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4. TITLE AND SUBTITLE Representation & Recognition with Algebraic Invariants & Geometric Constraint Models			5. FUNDING NUMBERS DARPA Order No.: 8228 Contract No.: MDA972-91-C-0053	
6. AUTHOR(S) Dr. Joseph L. Mundy			7. PERFORMING ORGANIZATION REPORT NUMBER	
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13. ABSTRACT (Maximum 200 words) The theory of invariants of repeated structures has been validated experimentally. This class of object description appears very promising and extends the usefulness of invariants to a broad class of man-made objects.				
<div style="border: 1px solid black; padding: 10px; text-align: center;"> DTIC SELECTED AUG 1 5 1994 F </div>				
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Software & Intelligent System Technology Office
Representation and Recognition
With Algebraic Invariants and
Geometric Constraint Models
ARPA Order NO. 8228
Program Code No. N/A
Contract No. MDA972-91-C-0053
Sept. 1, 1993 - Dec. 1, 1993

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July 29, 1994

DARPA/SISTO
Virginia Square Plaza
3701 N. Fairfax Drive
Arlington, VA 22203-1714

Attn.: Dr. Oscar Firschein


Subject: Quarterly Reports

Reference: Contract #MDA972-91-C-0053 titled "Representation and Recognition
with Algebraic Invariants and Geometric Constraint Models".

Please find enclosed one copy of the above-referenced report for the quarter ending
December 1, 1993. It is provided to you per Section F-67 of the referenced contract. This
report is approved for Public Release - Distribution Unlimited.

Please call if you have further questions.

Regards,



Elizabeth J. Malloy
Contract Administrator
Tel: (518) 387-7850, (FAX -7962)

Enclosures

- cc:
1. Defense Technical Information Center
Cameron Station, Attn.: DTIC-FDAC
Alexandria, VA. 22304-6145 (two copies)
 2. DARPA/SISTO
Attn.: Edward R. Brown
3701 North Fairfax Drive, 7th Floor
Arlington, VA 22203-1714

Progress

Sept. 1, 1993 - Dec. 1, 1993

Progress during this period is as follows:

- Initial experiments to test invariants for 3D repeated structures indicate that reliable affine structure can be recovered for translational symmetries.
- An algorithm for matching triples of parallel lines based on length ratio invariants has been evaluated and gives reliable results on Fort Hood test imagery.
- An occupancy measure, based on the statistics of edgel chains and chain junctions has been evaluated and gives reasonable qualitative results on various parking areas at the Fort Hood site.

Activities For Next Reporting Period

The work planned for the next reporting period is as follows:

- Participate with AAI in the updating of the IUE specification.
- Upgrade the invariants recognition system in Target Jr with a new class hierarchy design.
- Evolve a new architecture for 3D object recognition based on model classes which support the computation of invariants from single 2D image views.

Equipment Purchased

None

Changes in Key Personnel

None

Summary of Information

The theory of invariants of repeated structures has been validated experimentally. This class of object description appears very promising and extends the usefulness of invariants to a broad class of man-made objects.

Areas of Concern

None

Related Accomplishments

A second international workshop on invariants was held in Porto Delgada, Azores, co-sponsored by ARPA and ESPRIT, on October 9-14. Over 30 participants exchanged new results on the theory and implementation of invariant-related research.

Algebraic 11/93

COST AND MANHOUR TRACKING REPORT

REPORT DATE:

November 1993- FW348

5340-8-9064

CONTRACT NO: MDA972-91-C-0053

CONTRACTOR: GENERAL ELECTRIC CO

CORPORATE RESEARCH & DEVELOPMENT

Representation & Recognition with Algebraic Invariants

	PRIOR YEARS		LAST MONTH	CURRENT	CURRENT	TOTAL TO
	1991	1992	YTD	MONTH	MONTH YTD	DATE
MATERIALS	0.4	70.6	82.84	4.2	87.08	158.110
DIRECT LABOR	60.3	154.8	74.1	0.0	74.1	289.184
PROJECT COST	145.8	434.4	251	4.3	255.25	835.480
EAC	9.2	21.3	13.8	0.2	14.0	44.511
B&P	0	0.0	23.8	0.4	24.2	24.249
COST OF MONEY						
D/L	7.1	13.7	6.3	0.0	6.3	27.076
P/C	0.1	0.1	0.0	0.0	0.0	0.200
FEE	4.9	14.1	8.9	0.1	9.0	28.059
				0.0		
TOTAL CONTRAC	167.0	483.7	303.8	5.0	308.9	959.575

PROJECT COST

TASKS	MANHOURS		PRIOR YEARS		1993	
	YTD/91/92	YTD/93	TTD - P/C	TOTAL	TTD - P/C	TOTAL
ALL	2820	1151.2	580.2	650.7	255.3	308.9
TOTAL		3971.2	580.2	650.7	255.3	308.9

P.S. The correct manhours for October is: 1151.2 . 0 hours for November.

O. Erwin

12/8/93

Algebraic 10/83

COST AND MANHOUR TRACKING REPORT

CONTRACT NO: MDA972-91-C-0053
CONTRACTOR: GENERAL ELECTRIC CO
CORPORATE RESEARCH & DEVELOPMENT

REPORT DATE:
October 1983- FW344
5340-8-9064

Representation & Recognition with Algebraic Invariants

	PRIOR YEARS		LAST MONTH YTD	CURRENT MONTH	CURRENT MONTH/YTD	TOTAL TO DATE
	1991	1992				
MATERIALS	0.4	70.6	81.69	1.2	82.84	153.870
DIRECT LABOR	60.3	154.8	72.9	1.2	74.1	289.179
PROJECT COST	145.8	434.4	247.22	3.8	251	831.230
EAC	9.2	21.3	13.6	0.2	13.8	44.277
B&P	0	0.0	23.5	0.4	23.8	23.845
COST OF MONEY						
D/L	7.1	13.7	6.2	0.1	6.3	27.076
P/C	0.1	0.1	0.0	0.0	0.0	0.199
FEE	4.9	14.1	8.7	0.1	8.9	27.911
				0.0		
TOTAL CONTRAC	167.0	483.7	299.2	4.6	303.8	954.539

PROJECT COST

TASKS	MANHOURS		PRIOR YEARS		1993	
	YTD/91/92	YTD/93	TTD - P/C	TTD - P/C	TTD - P/C	TOTAL
ALL	2820	1127.2	580.2	650.7	251.0	303.8
TOTAL		3947.2	580.2	650.7	251.0	303.8
						954.5

O. Erwin 11/4/93

Algebraic 9/93

REPORT DATE:

September 1993- FW339

5340-8-9064

COST AND MANHOUR TRACKING REPORT

Representation & Recognition with Algebraic Invariants

CONTRACT NO: MDA972-91-C-0053
CONTRACTOR: GENERAL ELECTRIC CO
CORPORATE RESEARCH & DEVELOPMENT

	PRIOR YEARS		LAST MONTH YTD	CURRENT		TOTAL TO DATE
	1991	1992		MONTH	MONTH YTD	
MATERIALS	0.4	70.6	81.62	0.1	81.69	152.720
DIRECT LABOR	60.3	154.8	67.4	5.5	72.9	288.021
PROJECT COST	145.8	434.4	234.6	12.6	247.22	827.450
EAC	9.2	21.3	12.9	0.7	13.6	44.070
B&P	0	0.0	22.3	1.2	23.5	23.486
COST OF MONEY						
D/L	7.1	13.7	5.7	0.5	6.2	26.978
P/C	0.1	0.1	0.0	0.0	0.0	0.198
FEE	4.9	14.1	8.3	0.5	8.8	27.777
				0.0		
TOTAL CONTRAC	167.0	483.7	283.8	15.4	299.3	949.959

PROJECT COST

TASKS	PRIOR YEARS		1993	
	TTD - P/C	TOTAL	TTD - P/C	TOTAL
ALL	580.2	650.7	247.2	299.3
TOTAL	580.2	650.7	247.2	299.3

MANHOURS

TASKS	YTD/91/92	YTD/93
ALL	2820	1127.2
TOTAL	3947.2	

O. Erwin

10/13/93

GE Corporate Research & Development
Representation & Recognition with Algebraic
Invariants & Geometric Constraint Models
DARPA Order No. 8228
Contract No. MDA972-91-C-0053

R&D Status Report
Program Financial Status
Quarter Ending December 1, 1993

	Planned Expend.	<u>CUMULATIVE TO DATE</u>		<u>AT COMPLETION</u>	
		Actual Expend.	% Compl.	BAC	LRE
Remarks					
Subtotal	972,386	835,487	85.9	1,447,606	1,447,606
Management Reserve					
Unallocated Resources					
TOTAL	972,386	835,487	85.9	1,447,606	1,447,606